1976-09

Analysis of U.S. Navy major aircraft accident rates by aircraft type

Johnson, Gary Fredric

Monterey, California. Naval Postgraduate School

http://hdl.handle.net/10945/17671

ANALYSIS OF U. S. NAVY MAJOR AIRCRAFT ACCIDENT RATES BY AIRCRAFT TYPE

Gary Fredric Johnson

NAVAL POSTGRADUATE SCHOOL
Monterey, California

THESIS

ANALYSIS OF U. S. NAVY MAJOR AIRCRAFT
ACCIDENT RATES BY AIRCRAFT TYPE

by

Gary Fredric Johnson

September 1976

Thesis Advisor: G. K. Poock

Approved for public release; distribution unlimited.

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Analysis of U. S. Navy Major Aircraft Accident Rates by Aircraft Type		5. TYPE OF REPORT & PERIOD COVERED Master's Thesis September 1976
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Gary Fredric Johnson		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Naval Postgraduate School Monterey, California 93940		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS Naval Postgraduate School Monterey, California 93940		12. REPORT DATE September 1976
		13. NUMBER OF PAGES 52
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office) Naval Postgraduate School Monterey, California 93940		15. SECURITY CLASS. (of this report) Unclassified
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

** Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Accident
Aircraft

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

An analysis of U. S. Navy major aircraft accidents during the period Fiscal Year 1972-1974 was conducted. Forward (stepwise) Multiple Regression techniques were employed on a group of ten basic variables considered time dependent. The multiple regression techniques were employed to develop predictive equations for the dependent variable, Accident Rate with a view to

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE
(Page 1) S/N 0102-014-6601 |

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

determining which of the basic variable measures were significant in accident rate studies and if the variables are unique to a specific aircraft community or generally applicable to all aircraft.

Aircraft considered independently were A-4, A-6, A-7, and F-4, additionally composites of Attack aircraft (A-3, A-4, A-5, A-6, A-7), Fighter Aircraft (F-4 and F-8), Propeller aircraft (E-1, E-2, C-1, C-2, S-2, P-3, C-117, C-118, and C-130) and Helicopters (H-1, H-2, H-3, H-46, and H-53) were considered.

ANALYSIS OF U. S. NAVY MAJOR AIRCRAFT ACCIDENT RATES BY AIRCRAFT TYPE

by

Gary Fredric Johnson
Lieutenant, United States Navy
B.A., Bemidji State College, 1968

Submitted in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE IN OPERATIONS RESEARCH

from the

NAVAL POSTGRADUATE SCHOOL

September 1976

ABSTRACT

An analysis of U. S. Navy major aircraft accidents during the period Fiscal Year 1972 - 1974 was conducted. Forward (stepwise) Multiple Regression techniques were employed on a group of ten basic variables considered time dependent. The multiple regression techniques were employed to develop predictive equations for the dependent variable, Accident Rate with a view to determining which of the basic variable measures were significant in accident rate studies and if the variables are unique to a specific aircraft community or generally applicable to all aircraft.

Aircraft considered independently were A-4, A-6, A-7, and F-4, additionally composites of Attack aircraft (A-3, A-4, A-5, A-6, A-7), Fighter aircraft (F-4 and F-8), Propeller aircraft (E-1, E-2, C-1, C-2, S-2, P-3, C-117, C-118, and C-130) and Helicopters (H-1, H-2, H-3, H-46, and H-53) were considered.

TABLE OF CONTENTS

I. INTRODUCTION

The increased sophistication of military aircraft and the related increased dollar costs of procuring both aircraft and pilcts places ever greater emphasis on the importance of determining a feasible method of reducing losses through aircraft accidents. Many research efforts to date have dealt with determining the causal factors underlying an aircraft accident, then using these causal factors, attempting to develop predictive models for accident occurence.

Aircraft accidents have been broadly categorized in terms of aircraft design malfunctions, aircraft equipment failures, pilot or flight personnel error, and weather as primary causes for occurrence of mahor aircraft accidents. An accident is designated as a major accident if: 1) loss of life is involved; 2) complete loss of an aircraft is involved; or 3) substantial damage occurs to any aircraft involved. Substantial damage is defined in appendix A of OPNAVINST 3750.6 (series).

The most common cause of aircraft accident cited has been pilot error. Brictson, et. al. (1969) studied a four year span of aircraft carrier landing accidents involving attack and fighter aircraft. Approximately seventy-eight percent of the accidents studied had pilot error as the primary causal factor. Brictson noted that the majority of the accidents were of two types, hard landings and undershooting the landing area. The small deck carriers accounted for seventy percent of the total accidents even though the large deck carriers had more activity.

Studies conducted for the Royal Air Force by Goorney (1965) dealt with the human factors involved in pilot error. He determined that pilot fatigue, emotional stress, complacency, lack of current flying experience contributed to pilot error and, if monitored, could lead to prediction of the likelihood of pilot error related accidents.

There are some analysts who feel that if pilot error is a primary cause of accidents then the more proficient pilot should make fewer errors. This belief leads to the hypothesis that measures of pilot proficiency could be used as predictive measures. Keller (1961) hypothesized that flight time was positively correlated with pilot proficiency. He stated that were a pilot to fly the proper amount he would attain a safe proficient ability as a pilot. The procedure of how to determine the proper amount of flight time necessary to attain proficiency and how the number of hours needed would interact with fatigue and complacency were not fully explored.

Collicot, et. al. (1972) compared accident rates of single-seat aircraft with those of dual piloted aircraft. They noted that if the operations were about equal the dual piloted aircraft had fewer accidents per ten thousand flight hours than the single piloted versions. Though the authors refer throughout their study to pilot proficiency they also allude to a possibility of temporary mental overload as a critical factor underlying pilot error.

The determination of pilot error tends therefore to expand to include emphasis on temporary mental overload as well as pilot proficiency measures. Efforts by Kowalsky, et. al. (1974) were made to examine causal factors in high pilot error rates. Previous efforts to reduce pilot error had concentrated on improving pilot proficiency. Kowalsky and his co-researchers used cluster analysis and pattern

recognition techniques and discovered that the single most important causal factor was that, for non-training, non-midair accidents, pilots were often temporarily overloaded and incorrectly evaluated information presented during the period of overload.

Many studies and much effort has been expended in accident research. The extensive data base maintained by the Naval Safety Center of accident related information opens doors for further statistical analysis of accident rates with goals of constructing useful predictive mathematical models.

Myers (1974) hypothesized that measures of pilot proficiency and experience available in data collection banks would be sufficient to construct a predictive model. He used statistical techniques of principle component analysis applied to two groups of fifty pilots. One group, pilots who had been involved in aircraft accidents, the second, pilots with no accidents. The results were not as good as was desired, possibly due to the limited sample sizes employed.

A second approach was used by Stucki and Maxwell (1975) who used the techniques of regression analysis applied to data on over two thousand aircraft accidents as collected by the Naval Safety Center. Their efforts dealt with pilot proficiency variables, aircraft variables and type of flight information. They then applied regression analysis to the composite group of all accident involved aircraft in the Navy's inventory. This effort yielded a predictive equation composed of four pilot related variables to predict variations in aircraft accident rates.

Work by Robino (1974) reported fluctuation in aircraft by months with the month of March significantly higher.

Subsequent efforts in this area by Poodk (1976) failed to support the March phenomena and go on to demonstrate that fluctuations in aircraft accident rates by month is purely random.

The author of this study believes that the premise promoted by Myer, Stucki and Maxwell and others is valid. There should be sufficient data available on current aircraft accidents to conduct detailed statistical analysis with the resultant predictive equations both meaningful and useful. The variable nature of aircraft accident rates suggest that the underlying factors may be definable and, if they can be determined, used in accident prevention.

If statistical analysis of aircraft accident rates can provide information on accident related variables, be they pilot-oriented, aircraft oriented or related to some other source, which vary either directly or inversely with aircraft accident rates then preventative actions can be taken to suppress the enormous costs in dollars and human life associated with aircraft accidents.

II. NATURE OF THE PROBLEM

Monthly accident rates exhibit a marked variability when each calendar month is compared to other months. The belief that some months are consistently higher that others has been noted frequently in studies. This phenomena has been noted in studies of U. S. Air Force accident rates by Zeller and March (1973) and by Robino (1972) in a study of Navy aircraft accident rates. Recent work by Poock (1976) at the U. S. Naval Postgraduate School displays no statistical basis for any month being consistently high and attributes the fluctuations to random effects of the underlying causal factors.

The accident rate is defined as the total number of accidents in a given month times ten thousand hours divided by the total number of flight hours flown that month.

The efforts of this study, motivated by work of Stucki and Maxwell (1975), were to explore accident rate dependence on time related variables by specific aircraft types where possible and composites of aircraft types where necessary. The results desired are a series of predictive equations unique to a specific aircraft or a community. It is believed that if in fact aircraft type has no large effect on accident rates that the data will yield similar equations for each type considered.

III. ANALYTICAL PROCEDURES

This chapter contains the data selection procedure, the techniques employed in data preparation, a description of the analysis procedures and a summary of decision criterion employed in selecting the best equation for predicting the variance in the dependent variable rate.

A. DATA SOURCE

All Navy and Marine aircraft accidents and incidents are reported in detail to the Naval Safety Center, NAS, Norfolk, Va. The reporting criteria is detailed in Navy Aircraft Accident, Incident and Ground Reporting Procedures (OPNAVINST 3760.6(series)). As Naval Safety Center is a repository for all data recorded on aircraft accidents they are the source of data used in this report.

B. DATA SELECTION

As the goal of this study is to apply the concept envisioned by Stucki and Maxwell (1975) to individual type aircraft where possible and to group type of ai rcraft where necessary, the same basic data set as provided Stucki and Maxwell by the Naval Safety Center was employed.

Table 1 lists the data initially requested from and provided by Naval Safety Center.

TABLE 1

DATA SET REQUESTED FROM NAVAL SAFETY CENTER

Data concerning the pilot:

1. Age
2. Injuries
3. Number of previous service tours
4. Total flying time in aircraft model in which accident occurred
5. Total flight hours in previous ninety days
6. Total nighttime flight hours in previous ninety days
7. Total daylight carrier landings in previous thirty days
8. Total night carrier landings in previous thirty days
9. Number of years as designated Naval Aviator

Data concerning aircraft:

1. Model
2. Damage
3. Number of tours between major aircraft rework
4. Type of last major inspection
5. Hours since last inspection
6. Identification of the system or component failure

Data concerning the flight:

1. Major command
2. Reporting custodian
3. Ships's hull number (if applicable)
4. Marine Air Wing (if applicable)
5. Location
6. Flight Purpose Code
7. Type of operation code
8. Phase of operation in which the accident occurred

Data concerning the accident:

1. Accident identification number including calendar date
2. Other aircraft damaged
3. Other personnel injured
4. Contributing causal factors
5. Special data not otherwise listed
6. Weather
7. Accident rate for the month in which the accident occurred

From the available data set ten basic variables were selected in cooperation with Naval Safety Center personnel

for inclusion in this study (see Table 2).

In general, multiple regression requires that variables are measured on interval or ratio scale and that the relationships among the variables are linear and additative.

The data set provided consisted of information on Two-Thousand-One-Hundred-Ten accidents or incidents which occurred during Fiscal Years 1969 to 1974, inclusive. Selection of a suitable time span was based upon the following basic constraint considerations:

(1) The necessity to have as large a sample size as possible to enhance validity of statistical inferences.

(2) The desire to restrict the years in the sample to periods when the aircraft inventory was reasonably consistent.

(3) The necessity to consider gaps and inconsistencies in desired data points due to changes and/or modifications in data collection requirements and recording procedures that had occurred within the Accident Reporting System.

To accomplish these major considerations the entire data base was initially included. Then each variable was examined throughout the entire data set in terms of how changes in the reporting procedure or inconsistencies in the data would effect that variable. This treatment resulted in the reduction of the data base to the Five-Hundred-Sixty-Nine accidents occurring during the three year period FY 72-74 inclusive.

During this period the inventory of aircraft with which this study deals was reasonably constant.

While this treatment did create a complete data base wherein all information desired was available for all accidents the resulting size does hamper the investigation of aircraft types in cases where the inventory is small to begin with and/or where there are few accidents as in the A-3 community. This leads in some instances to grouping data under categories such as Propeller, Attack or Helos.

C. VARIABLE SELECTION

The ten basic variables selected for inclusion are shown in Table 2.

TABLE 2

DATA SET INCLUDED IN CURRENT STUDY

1. Accident rate by month (RATE)
2. Pilots age (AGE)
3. Total flight time in accident involved aircraft model (TTIME)
4. Total flight time during ninety days preceding accident (TOT90)
5. Total night flight time during the preceeding ninety nights (NITE90)
6. Daylight carrier landings during the preceeding thirty days (CLDAY)
7. Night carrier landings during the preceeding thirty nights (CLNITE)
8. Number of aircraft tours (ACTOUR)
9. Aircraft flight hours since last major or calender inspection (ACHRS)
10. Number of years designated Naval Aviator (DNA)

In addition to the basic variables the author used an eleventh variable, DAY90 = TOT90 - NITE90, which is the total daylight flight time in the preceeding ninety days.

Pilots age and years designated Naval Aviator were included as they are variables that are historically used as indicators of maturity and perhaps proficiency. If, as the author believes, the hypothesis that the older pilots tend to be safer pilots through a finer sense of judgement of risks involved is a valid hypothesis, the author would expect a negative simple correlation between AGE and DNA with rate. However because the number of other confounding factors is great a negative correlation would not justify the acceptance of the hypothesis.

The variables consisting of pilot flight hours and carrier landings are considered to be measures of pilot currency and proficiency by many in the Navy and are

therefore included.

Aircraft tours is included as a measure of the general condition of the aircraft and as an indication of aircraft age. Each aircraft in the Navy's inventory undergoes a Periodic Aircraft Rework (PAR) for analysis, repair and conversion at intervals unique to the model aircraft after a specific number of flight hours. This variable also serves to monitor any reliability anomalies other than "new-better-than-used" as mentioned by Butterworth, et.al. (1974).

Aircraft hours is included as a measure of aircraft condition and usage since major inspection, primarily the calendar inspections.

D. DATA PREPARATION

The basic assumptions for multiple regression analysis require that data be measured in at least interval or ratio scale and that the relationship among the variables be linear and additive.

All data points used were ajudged to be measured on an interval scale. Raw data for each type or group of aircraft was averaged by months for each of the thirty-six months included in the data set where there was an accident for that type aircraft.

E. THE ANALYSIS TECHNIQUE

The analysis procedure employed was Multiple Regression using Forward(stepwise) Inclusion. The Statistical Package for the Social Sciences(SPSS) compiled and edited by Nie, et.al.(1955) includes a forward stepwise multiple regression computer program package developed by Jae-On Kim and Frank J. Kohout at the University of Iowa.

This package was selected as the means of conducting the statistical analysis of the data sets.

Kim and Kohout state that forward stepwise multiple regressicn is a recognized technique: "(1) to find the best linear prediction equation and evaluate its prediction accuracy; (2) to control for other confounding factors in order to evaluate the contribution of a specific variable or set of variables; and (3) to find structural relations and provide explanations for seemingly complex multivariate relationships, such as is done in path analysis."

The computer program provides the user with various options for treatment of data sets, calculation of statistics and output formats. The procedure, Listwise Deletion of Missing Data, is the default option and the most conservative in that it maintains sample size and is the most accurate. Since the data base finally arrived at was complete, no data was deleted by the computer program option. If the data base were missing quite a few individual data points this procedure could result in a drastic decrease in the sample size. This fact was one of the underlying considerations in the data base selection criteria.

The options not selected could, if not used with considerable prudence and judgement, result in the introduction of large amounts of bias that would be very difficult to detect without a very good feel for expected experimental results. It is for this reason that the Listwise Deletion of Missing Data option was used for all computer runs in the current study. Kim and Kohout state that:

> "There are many occasions for which simple linear models are inadequate. It may be that (1) the bivariate relationship is expected (on the basis of theory) to take a specific nonlinear form, (2) the bivariate relationship is simply unknown, and the examination of the scatterplots suggests clear deviation from linearity or, at least, the need for testing the adequacy of the linearity assumption, or (3) the combined effects of the independent variables are not additive. Some of the ways to handle these types of nonlinear situations are (1) to transform the original variables in such a way that the resultant relationships among the transformed variables become linear, (2) to find

a simple nonlinear form through the use of polynomial regression, and (3) to introduce interaction terms as new variables."

There are two extreme viewpoints in regression analysis, with valid arguments to support both cases. Draper and Smith (1966) explain that the two opposing viewpoints are "(1) to make the prediction equation valid you should include as many predictor variables as possible; and (2) because of increased cost of obtaining variables and monitoring them, the equations should include as few variables as possible."

The process of selecting the best regression equation is the process of compromising between these two extreme viewpoints. There is no unique statistical procedure for choosing the 'best' equation and large amounts of personal judgement are required. In this regard the techniques of regression analysis become an art as well as a science.

Initial analysis of data from the current study displayed indications of nonlinearity and interactive effects between independent variables.

To deal with these effects no single set of regression variables were deemed 'best' but rather a series of seven different regression variable packages were constructed. Each data set was run with all seven different packages.

Variables eight and nine from Table 2 were deemed aircraft oriented variables while the remaining basic variables were considered human oriented measures.

Regression I consisted of only those basic variables that were human related. Regression II contained all the basic variables pilot or aircraft oriented. Regression III used the pilot oriented basic variables plus transformations

consisting of the square and the square root of each basic variable used. Regression IV includes all of Regression III plus the square of, the square root of and the two aircraft related basic variables. Regression V contains all of Regression III plus the twenty-eight possible cross-products of the eight basic variables. Regression VI contains all of Regression V plus the aircraft related basic variables, their squares and square roots and the cross product of Aircraft Tours and Aircraft Hours. Regression VII contains the ten basic independent variables, their squares, square roots and the forty-five possible cross-products.

The decision to employ squares and square roots was made to provide a larger number of variables capable of accounting for curvilinearty. The introduction of cross-products allows for interactive effects of independent variables. The use of the Forward (stepwise) Inclusion Multiple Regression computer program facilitates the creation and inclusion of many various transforms. The packages used in the study were considered the most versatile of the trial packages used in preliminary studies by the author.

F. DECISION CRITERIA

The forward stepwise multiple regression program contains preselectable stopping criteria that were adjusted to facilitate introduction of variables into the equation that by themselves made a significant contribution to explaining the variance in the dependent variable RATE. As a 'rule-of-thumb' in predictive equation selection the study attempts to restrict the number of variables in each equation to five. This decision is based upon the degrees of freedom in the regression equation and the need to

maintain a significant ratio to provide a solid statistical base for conclusions.

With the degree of freedom restrictions attained the primary decision criteria are:

1) The equation with a significance level of 100(1-alfa) percent greater than or equal to ninty-five percent, and

2) That equation that accounted for the largest amount of variance in the dependent variable.

In those cases where the choice of the 'best' equation was not clearly indicated other more subjective measures were employed, such as, examination of scatterplots of the standardized residual versus the standardized predicted dependent variable, the plot of the standardized residuals, and consideration of the intuitive impact of the particular variables in the equations under consideration.

For example, all other decision criteria being statistically equal the equation containing CLDAY - $(\mathrm{CLDAY})^2$ + (RTCLDAY) would be selected over the equation containing (AGE)(ACTOURS) + (TTIME)(ACHRS).

Since many of the regression packages were very similar some cases cculd yield the same equations for more than one regression package, while other cases could yield no significant equation for any regression package. In either case for ccmpleteness the 'best' equations is indicated in the results even if that equation is not statistically significant.

This chapter has described the analysis procedures used in the development of predictive equations for variance in

accident rates by month. The next chapter contains the results of the analysis by aircraft community and aircraft type where possible.

IV. RESULTS

The results by aircraft type or aircraft community are contained in this chapter. The best predictive equation provided by the seven Regression Packages are shown.

A. ATTACK AIRCRAFT

The aircraft of the attack community were divided into a composite regression and three separate regressions. The composite consisted of accident involved aircraft of the types A-3, A-4, A-5, A-6, and A-7. All variants of each type aircraft were included (for example, KA-3, EA-3 and A-3). The three separate regressions were conducted on A-4, A-6, and A-7 respectively.

1. Attack Composite

This category was used to investigate trends unique to the Attack community and not peculiar to a specific attack type aircraft. Additionally, the relatively small size of the A-3 and A-5 communities precluded an independent analysis of these aircraft. Rather than omit A-3's and A-5's they were included here. The accident involved aircraft in this category provided the maximum sample size of thirty-six data points for analysis. As the number of aircraft included of each type are not equal the category may be biased towards the larger A-4 and A-7 communities, however, the author felt that this would in no way endanger

the results as the Attack community is being considered as a community. While data was available for A-1's they were not included for two reasons, firstly, it was desired to limit the category to jet aircraft and secondly, the A-1 has been phased out of the active aircraft inventory.

The basic variables in the regression accounted for less than twenty percent of the variance in accidents rate, however, the regressions consisting of transformed variables yielded two equations of approximately equal quality which are:

A. Rate(ATTACK) = 0.98593 - 0.01221 $(ACTOUR)^2$ + 0.00232 (ACHRS) - 0.00226 $(CLDAY)^2$ + 0.62245 (RTCLNITE) - 0.00193 $(NITE90)^2$

and,

B. Rate(ATTACK) = 0.79467 - 0.00268 $(CLDAY)^2$ + 0.68955 (RTCLNITE) - 0.00664 $(NITE90)^2$ + 0.15186 (NITE90) - 0.09602 (RTTOT90).

Equation A and equation B are both significant at the 99 percent level and equation B accounts for 59.74 percent of variance in rate contrasted to 51.11 percent for equation A. The author's decision criteria were met by both equations, however, examination of residual plots favored equation A by a narrow margin. The Forward (stepwise) Regression criteria selects variables for inclusion in the predictive equation by adding the variable that accounts for the largest increase in the percent of variance in the dependent variable. It is of interest to note that the aircraft oriented variables entered the predictive equation first in Equation A followed by the pilot oriented variables. With the deletion of aircraft variables the second equation provided by only pilot oriented variables

accounted for an additional 8.63 percent of variance in rate but with a lesser initial effect of the first two variables added.

It can be observed that equation A contains two aircraft related variables while equation B is composed entirely of pilot oriented variables of which three are included in both equations. The predictive equation (B) contains the variable NITE90 in two functional forms. The net effect on the dependent variable rate is positive for values of NITE90 less than or equal to 22.87 hours. For hours greater than 22.87 the effect is to reduce the predicted monthly accident rate.

2. A-4 Aircraft

This category contains all accident involved A-4 and TA-4 aircraft in the three year period studied and provides a sample size of thirty-one cases. The regression of the basic variables accounted for only 22 percent of variance in rate at a significance level of 75 percent. The predictive equation considered 'best' was:

$$\text{Rate(A-4)} = -0.00804\ (\text{DNA})^2 + 0.10473\ (\text{RTACHRS}) - 0.00010\ (\text{DAY90})^2 + 0.77584\ (\text{RTNITE90}) - 0.11160\ (\text{NITE90}) - 0.13246.$$

This equation, significant at the 95 percent level, accounts for 42.68 percent of the variance in rate.

It is noted that four of the five variables are pilot oriented variables three of which are based on hours flown. The predictive equation for A-4 aircraft contains NITE90 in two functional forms as did the predictive equation for the Attack community. Again as in the Attack

community the net effect of NITE90 is positive for the lower number of hours flown. Particularly the net effect is positive for NITE90 less than or equal to forty-eight hours and negative for values greater than forty-eight.

3. A-6 Aircraft

This category was restricted to a sample size of twenty due to relatively few accidents and a smaller community. In order to achieve the largest sample size possible the author included EA-6 aircraft with the A-6 and KA-6 models. The small sample size tends to make suspect any results derived by regression analysis.

The basic variables accounted for less than ten percent of the variance in rate while the 'best' predictive equation accounted for 40.27 percent. This equation is however significant only at the 75 percent level. The author feels that the small sample size tends to negate any usefulness of this regression. The equation is included for continunity of the study and for discussion purposes. The equation is:

$$\text{Rate(A-6)} = 16.28967 - 0.04604\ (\text{DNA})^2 + 2.33592\ (\text{RTDNA}) - 20.30561\ (\text{RTACTOUR}) + 5.34649\ (\text{ACTOUR}) + 0.05874\ (\text{RTTIME}).$$

It is noted here that only three basic variables are used in scme functional form with a balance of aircraft and pilot oriented variables used. The independent variables DNA and ACTOUR are each used in two functional forms. The net effect of ACTOURS is positive for values greater than or equal to 15 tours while the net effect of DNA on the dependent variable rate is positive for values less than or equal to 13.70 and becomes negative for values greater than

13.7 years.

4. A-7 Aircraft

This category provides a sample size of thirty-two cases based on all A-7 aircraft models involved in accidents during the study period. The regression analysis yielded the following predictive equation:

Rate(A-7) = 0.27170 (RTCLDAY) - 0.01856 $(\text{CLNITE})^2$ + 0.21346 (RTNITE90) + 4.01164 (RTDNA) - 0.88896 (DNA) - 3.70545.

This equation, significant at the 99 percent level accounts for 55.01 percent of the variance in rate.

The predictive equation for A-7 aircraft also contains two functional forms of DNA. Again here as in the A-6 the net effect is negative for large values of DNA, greater than 21 years in this case. While the effect on rate is positive for values less than 21 years the net effect decreases as the value of DNA approachs 21 years. This agrees with the intuitive feeling that DNA is a measure of pilot proficiency and the more experience the safer the pilot.

TABLE 3

ATTACK AIRCRAFT VARIABLE SUMMARY

VARIABLE	ATTACK-A	ATTACK-B	A-4	A-6	A-7	FREQ
NITE90		0.07382	0.12366			2
ACTOUR				-0.17445		1
ACHRS	0.31152					1
DNA					0.15431	1
DAY902			-0.12592			1
NITE902	-0.04184	-0.04184				1/1
CLDAY2	-0.31728	-0.31728				1/1
CLNITE2					-0.23345	1
ACTOUR2	-0.37244					1
DNA2			-0.31353	-0.34703		2
RTTIME				-0.03596		1
RTTOT90		0.06426				1
RTNITE90			0.22177		0.22398	2
RTCLDAY					0.34684	1
RTCLNITE	0.13914	0.13914				1/1
RTACTOUR				-0.14537		1
RTACHRS			0.30860			1
RTDNA				-0.24288	0.22979	2

TABLE ENTRIES ARE THE CORRELATION COEFFICIENT OF THE DISPLAYED VARIABLE WITH RATE

Table 3 displays the basic and transformed variables as used in the regression package. The suffix '2' indicates that variable squared and the prefix 'RT' the square root of the variable. Tabled are the correlation coefficients of the displayed variables with the dependent variable rate.

For those cases where the variable appears in more than one equation the correlation coefficients are quite

consistant with the exception of RTDNA where the coefficient for A-7 is contrary to what would be normally considered true. While it is generally believed, the remaining aircraft types bear out, that the adage that the older, more experienced pilot has fewer accidents, this does not appear to hold for the A-7 aircraft. It is noted that the values for DNA and RTDNA in Table 3 for A-7 are positively correlated, in addition the coefficient for pilot age is also positively correlated for A-7. The author is unable from his experience to explain this unusual occurance.

TABLE 4

ATTACK AIRCRAFT BASIC VARIABLE SUMMARY

VARIABLE	ATTACK-A	ATTACK-B	A-4	A-6	A-7	FREQ
AGE						0/0
TTIME				1		1/1
TOT90		1				0/1
DAY90			1			1/1
NITE90	1	2	2		1	4/5
CLDAY	1	1			1	2/2
CLNITE	1	1			1	2/2
DNA			1	2	2	5/5
ACTOUR	1			2		3/2
ACHRS	1		1			2/1

Table 4 relates the usage of basic variables in each category in some functional form. Basic variables AGE, TTIME, TOT90, and DAY90 are used one time or less indicating that these measures have little or no effect on predicting variance in aircraft accident rates. NITE90 and DNA are the high usage variables followed by CLDAY, CLNITE, ACTOUR and ACHRS with moderate usage.

B. FIGHTER AIRCRAFT

The analysis of fighter aircraft was restricted to F-4 and a composite of F-4 and F-8 aircraft. The data base did not provide enough data to conduct independent analysis of F-8's by themselves which led to the composite category.

1. Fighter Composite

This category was included to provide a method of including F-8 aircraft and to facilitate the possible contrast of the Attack and Fighter communities.

The composite analysis yeilded a sample size of thirty-six cases primarily on the strength of the F-4 community. The basic variable regression accounted for less than twenty-five percent of the variance in rate at a significance level of 95 percent. Once again the regression using transformed variables provided a better predictive equation as shown below.

$$\text{Rate(Fighter)} = 1.21906(\text{RTACTOUR}) + 0.23768(\text{RTDAY90}) + 0.01897(\text{CLDAY})^2 + 2.38695(\text{RTCLDAY}) - 0.92126(\text{CLDAY}) - 2.48215.$$

This equation accounts for 40.45 percent of the variance in rate and is significant at the 99 percent level.

It is observed that the variable CLDAY appears in each of its functional forms and while it does not account for the most variance initially in conjunction with the forms of ACTOUR and DAY90 it adds about sixteen percent to the accounting of variance in rate. The net effect on the dependent variable rate of the variable CLDAY is positive for values less than or equal to 11.56 daytime carrier landings in thirty days. For values greater than 11.56 the

net effect becomes negative and will tend to decrease the accident rate.

2. F-4 Aircraft

The category of F-4 aircraft consisted of a sample size of thirty-six data points. Regression analysis yielded the following predictive equation:

$$\text{Rate(F-4)} = 0.19142\ (\text{RTDAY90}) - 0.03663\ (\text{CLNITE})^2 - 0.000002\ (\text{TTIME})^2 + 0.17982\ (\text{RTTIME}) - 0.01302\ (\text{DNA})^2 - 1.59073.$$

This equation accounts for 34.79 percent of variance of rate at significance level 95 percent. The equation generated by the basic variables alone accounted for less than nine percent and were not significant at the 75 percent level.

The predictive equation deemed 'best' was generated from Regression III and contained only pilot-oriented variables.

The variable TTIME appears here in two functional forms with a positive net effect on rate for values less than or equal to 2006 hours.

TABLE 5

FIGHTER AIRCRAFT VARIABLE SUMMARY

VARIABLE	FIGHTER	F-4	FREQ
CLDAY	-0.16666		2
TTIME2		-0.11285	1
CLDAY2	-0.26346		1
CLNITE2		-0.19546	1
DNA2		-0.16277	1
RTTIME		0.08688	1
RTDAY90	0.24865	0.23319	2
RTCLDAY	0.00643		1
RTACTOUR	0.44776		1

TABLE ENTRIES ARE THE CORRELATION COEFFICIENTS OF THE DISPLAYED VARIABLE WITH RATE

In the case RTDAY90 which appears in both equations the correlation coefficients are quite consistent. It is noted that the variables normally considered as pilot proficiency variables are negatively correlated with rate, except in the cases where square roots are used.

TABLE 6

FIGHTER AIRCRAFT BASIC VARIABLE SUMMARY

VARIABLE	FIGHTER	F-4	FREQ
AGE			0
TTIME		2	2
TOT90			0
DAY90	1	1	2
NITE90			0
CLDAY	3		3
CLNITE		1	1
DNA		1	1
ACTOUR	1		1
ACHRS			0

Table 6 relates the usage of basic variables in some functional form by category. The basic variables CLDAY, TTIME, and DAY90 are the high usage variables in this category and are all pilot related variables. The variables AGE, TOT90, NITE90 and ACHRS did not appear in any form in the fighter community

C. PROPELLER AIRCRAFT

The aircraft considered in the propeller aircraft category consisted of E-1, E-2, C-1, C-2, S-2, P-3, C-117, C-118, and C-130. Due to the relatively small size of each individual ccmmunity and the infrequency of accidents it was necessary to combine all aircraft into one category entitled 'PROPS'. This procedure is somewhat unnerving as there are normally aspirated and turboprop aircraft together as well

as carrier-based and land-based aircraft. This tends to bias the results and applications or inferences cannot be directed toward any particular member aircraft in the group.

The result of aggregating the above aircraft is a sample size of twenty-six cases which provides an equation of basic variables that accounts for less than thirty percent of the variance in rate at a significance level of seventy-five percent.

Regression packages V, VI and VII provided the same equation which was judged 'best' by the author.

$$\text{Rate(PROPS)} = 0.35935 + 0.00002[(\text{TTIME})(\text{NITE90})] - 0.00022\,(\text{NITE90})^2 - 0.00001\,[(\text{AGE})(\text{TTIME})] + 0.00108\,[(\text{CLDAY})(\text{DNA})] - 0.00595\,(\text{CLNITE})^2.$$

The predictive equation accounts for 43.25 percent of the variance in rate at a significance level of 95 percent. This category provides the only case where cross-products contribute to the predictive equation. The equation consists of only six basic variables in some functional form, and all six are pilot oriented variables. This could be indicative of the inherent safety of large multi-engined propeller aircraft where a flight may be aborted due to a mechanical failure with a lower probability of an accident resulting from the mechanical failure.

The inclusion of pilot oriented variables in the area of carrier landings casts doubt upon the validity of the predictive equation because many of the aircraft are not carrier-based and their pilots do not record carrier landings. The equation is still considered valid by the author in that a value of zero was recorded for those pilots with no carrier landings and if the regression technique still selects that variable it is due to the correlation interactions with that variable and the combined independent variables included in the equation with the dependent

variable rate.

TABLE 7

PROPELLER AIRCRAFT VARIABLE SUMMARY

VARIABLE	PROPS
NITE902	0.09764
CLNITE2	-0.22505
CLDDNA	0.21845
TTNITE	0.55415
AGEDNA	0.19878

TABLE ENTRIES ARE THE CORRELATION COEFFICIENT OF THE DISPLAYED VARIABLE WITH RATE

TABLE 8

PROPELLER AIRCRAFT BASIC VARIABLE SUMMARY

VARIABLE	PROPELLERS	FREQUENCY
AGE	1	1
TTIME	2	2
TOT90	0	0
DAY90	0	0
NITE90	2	2
CLDAY	1	1
CLNITE	1	1
DNA	1	1
ACTOUR	0	0
ACHRS	0	0

Table 7 shows that only one variable, CLNITE2, is negatively correlated with rate, while the remaining variable forms are all positively correlated. Table 8 reflects the degree of usage of each basic variable with total time and night hours being used twice and the remaining basic varaibles one time or not at all.

D. HELICOPTERS

The category helicopters consists of the aggregate of H-1, H-2, H-3, H-46 and H-53. This category like that of Propellers did not provide sufficient data to conduct independent analysis by type aircraft. The aggregate yielded a sample size of thirty-three cases.

The analysis yielded only two predictive equations for the seven regression packages. The equation provided by the basic variables was ajudged 'best' and is:

$$\text{Rate(HELO)} = 0.00062\ (\text{TTIME}) + 0.65405.$$

This equation, significant at the ninety percent level accounts for 9.30 percent of the variance in rate. The second equation provided by the remaining five regressions accounted for 11.45 percent of the variance in rate. The difference cf 2.15 percent was not deemed sufficient increase to use the second equation which consisted of the variable TTIME squared.

V. DISCUSSION

It is interesting to note that even though the variable AGE was the most significient single variable in the overall equation arrived at in the study by Stucki and Maxwell that AGE appeared only once in the current study. The variable AGE appeared as a cross product with TTIME in the prediction equation for propeller aircraft. The current study employs the variable DNA which was not used by Stucki and Maxwell. The variable DNA was used in some functional form seven times and represents the highest single useage of any basic variable. The simple correlation between AGE and DNA is quite high in each of the eight categorys. Intuitively this implys that one or the other will dominate and both will try to account for the same portion of variance in rate explainable by this type of variable. A similar trend appears in looking at the usage of TOT90, DAY90 and NITE90. As the sum of DAY90 and NITE90 equals TOT90 it would be expected that one of the variables would dominate the predictions. This is in fact the case as NITE90 is used six times, DAY90 three times and TOT90 enters only in the alternate best equation for Attack aircraft. The variables TTIME and CLDAY are each used six times in some functional form while CLNITE appears four times. The aircraft oriented variables appear a total of six times in some functional form, four times for ACTOUR and twice for ACHRS.

Although some of the Regression Packages yielded the same equation within categories, Regression Package IV can be credited with the best equation in five out of eight categories. Regression IV provided the best equation in the four attack aircraft categories and in the category Fighter aircraft. Regression Package V provided the Propeller equation, Regression II the Helicopter equation and

Regression III the F-4 equation. The predictive equation for F-4 is the only case where the best equation was provided by a regression package that contained only pilot oriented variables. The category consisting of Helicopters was the only case where the transformed variables did not provide a large improvement over pure basic variables in the predictive equation generated.

The majority of the variables entered in the eight predictive equations were of the variable squared or the square root of the variable, thirteen and fourteen times respectively. Three cross products used six variables and the basic variables appeared six times.

There does not appear to be any trend or tendency for any particular basic variable to be consistent over the range of the eight categories considered. If the hypothesis that the older more experienced pilot is a safer pilot is valid and if the variables of AGE and DNA can be considered as measures of this hypothesis, then the author would expect the simple correlation coefficients of these variables to be negative. This is not the case as five of the sixteen coefficients are positive. It is possible that due to the relatively small size of each sample and the fact that there are months where only one accident occured that a coefficient could be only slightly positive without violating the hypothesis. This does not explain the coefficients of the A-7 category (see Table 9) where the coefficient of AGE is on the order of 0.26 and DNA is 0.15. As stated previously the author is unable to explain this phenomena. Similar arguments can be generated for each of the ten basic variables. The closest case to being consistent in sign is with CLNITE where all coefficients are negative except that of A-6 which is 0.07. The value of 0.07 for A-6 combined with the extremely small sample considered in this case (20 data points) leads the author to discount any significance in sign for this variable.

TABLE 9

	ATTACK	A-4	A-6	A-7
AGE	-0.27305	-0.12430	-0.30084	0.26525
TTIME	-0.05110	-0.08715	-0.09278	0.17624
TOT90	0.02845	-0.01864	-0.02922	-0.03100
DAY90	0.01701	-0.08675	0.02350	-0.07358
NITE90	0.07302	0.12366	-0.11615	0.07386
CLDAY	-0.19153	0.05906	-0.02135	0.21725
CLNITE	-0.11847	-0.01026	0.07686	-0.03701
ACTOUR	-0.33037	-0.11151	-0.17445	-0.16477
ACHRS	0.31152	0.29628	0.10899	-0.11530
DNA	-0.18404	-0.25457	-0.28943	0.15431
	FIGHTER	F-4	PROPS	HELOS
AGE	-0.006448	0.00785	-0.06703	0.09091
TTIME	0.15639	0.01361	0.21211	0.30509
TOT90	0.11077	0.14855	0.08224	0.09746
DAY90	0.23847	0.20732	-0.00069	0.12454
NITE90	-0.22743	-0.14624	0.16823	-0.00036
CLDAY	-0.16666	0.10926	0.20479	**
CLNITE	-0.16156	-0.12479	-0.22141	**
ACTOUR	0.42709	0.19403	0.14963	-0.07866
ACHRS	0.03460	0.20765	0.12285	0.08244
DNA	-0.02518	-0.05232	-0.05969	0.04829

** no carrier landings recorded

TABLED VALUES ARE THE CORRELATION COEFFICIENTS OF THE BASIC VARIABLES WITH ACCIDENT RATE BY CATEGORY

The net effect on Rate by the combined functional forms of a basic variable was discussed in the results by category. It should be noted, however, that adjusting the values of a basic variable to bring about a decrease in the accident rate could potentially cause one of the other measures to shift in such a way that the total net effect would be to increase the accident rate.

VI. RECOMMENDATIONS

The current study consisted of analysis of aircraft accident rate by type aircraft. In this approach the size of the communities and the resulting size of the data base are such that the analysis is constrained by the degrees of freedom available in regression techniques. As a future study the techniques and hypotheses employed in this study would be a useful starting point. The necessity of a larger data base would be overcome by time as the inventory studied is not that different from the current Navy inventory. The sensitivity of some of the basic variables employed in this study suggest that future studies procure additional data of the following types:

1) In addition to the number of day and night carrier landings in the past thirty days, a numerical grade of the quality of each landing made should be included.

2) A breakdown of the hours flown in the preceeding ninety days to include, for example, flight hours in past 24 hours, flight hours in past 72 hours. This would allow inclusion of concepts of fatigue versus proficiency.

3) In addition to AGE and DNA, the number of months in operational flying billets and the number of months in current tour.

The data base employed contained much information on accidents and allows constructing a profile of the pilot who had an accident. The single most severe hinderance to this author in drawing conclusions was the lack of adequate or equal knowledge of the pilot who did not have an accident. It is recommended that prior to any future studies of this type the analyst procure data on accident free pilots with as many variables in common with the accident involved pilot as feasible. The hinderance to this author was that a

profile of the accident involved pilot may be identical to a profile of the non-accident involved pilot. Without the results of this comparison the usefulness of the predictive equations for prediction cannot be demonstrated statistically. It is possible however that the equations could be validated by using them to attempt to predict and comparing the actual resulting rates.

The real benefits of this study are in the analysis of the variables that enter the equations and by using the frequency of appearance in planning future studies with even greater detail in those areas where the variables appear to contribute the most.

While this study is somewhat broad in scope it does provide encouragement for future efforts along this line of reasoning. The ever increasing necessity to reduce loss in human life and dollars due to aircraft accidents provides the incentive.

APPENDIX A

AVERAGE MONTHLY DATA POINT VALUES

This appendix contains the average monthly data point values for the basic variables and the dependent variable, Rate. Each aircraft type or community examined in the study is recorded in a table.

The dependent variable Rate is the aircraft accident rate per ten thousand hours. Rate is calculated by taking the number of aircraft accidents for the month times ten thousand hours and dividing by the total number of hours flown by that type aircraft for the month.

MONTH	RATE	AGE	TTIME	TOT90	DAY90	NITE90	CLDAY	CLNITE	ACTOUR	ACHRS	DNA
JUL	0.38	29.00	172.00	87.00	62.00	25.00	16.50	7.00	1.50	105.00	5.00
AUG	1.71	29.50	488.70	64.00	58.20	5.80	4.11	0.88	3.80	133.60	4.50
SEP	1.38	28.10	616.00	79.30	69.70	9.50	1.63	0.50	2.50	108.80	4.10
OCT	1.83	31.00	686.70	69.00	57.20	11.80	7.40	2.10	1.70	110.50	6.50
NOV	1.68	29.10	296.60	54.90	45.10	9.75	2.86	0.14	2.67	155.89	4.90
DEC	0.99	27.60	417.40	78.80	59.40	19.40	0.80	0.40	3.40	99.20	3.60
JAN	1.76	28.90	425.20	72.70	53.50	19.20	6.44	1.70	2.10	81.50	5.80
FEB	1.27	25.30	267.10	68.80	49.70	15.10	7.80	1.30	1.60	91.70	4.20
MAR	1.59	29.10	506.10	53.90	42.10	11.80	5.80	1.90	2.20	105.70	5.90
APR	1.95	28.10	425.80	64.90	51.90	13.00	3.00	1.15	3.20	140.90	5.80
MAY	1.30	29.20	549.70	87.90	76.80	11.11	7.60	1.11	2.40	130.11	5.60
JUN	1.39	28.50	499.90	81.90	63.30	18.60	12.38	3.50	3.13	98.43	4.50
JUL	2.10	28.00	381.50	71.00	60.60	10.40	5.00	2.00	3.30	127.20	4.60
AUG	1.17	26.40	571.50	81.80	68.30	13.50	3.10	1.70	4.10	87.40	3.10
SEP	1.11	28.10	542.10	96.60	77.60	19.00	14.71	5.57	2.57	184.29	5.50
OCT	1.27	31.80	363.00	222.80	210.20	12.60	4.00	2.40	3.60	126.88	4.80
NOV	2.21	29.50	596.50	65.50	50.60	14.90	5.50	2.40	1.90	147.00	5.60
DEC	0.60	26.50	333.70	81.30	64.00	17.30	0.0	0.0	3.00	92.67	3.00
JAN	1.19	32.30	690.50	91.00	69.60	21.40	8.20	2.30	3.40	202.00	8.70
FEB	1.29	29.70	555.90	55.70	48.60	7.10	1.57	0.29	4.43	88.71	5.70
MAR	1.18	29.50	635.10	39.80	28.00	11.80	2.80	0.29	2.70	63.50	4.80
APR	1.03	30.00	682.50	82.30	68.60	13.70	3.00	0.67	3.80	107.30	6.30
MAY	1.75	29.10	565.30	67.10	50.00	17.10	3.80	2.80	2.10	70.20	5.20
JUN	0.74	26.50	686.50	75.30	66.00	9.30	1.30	0.0	1.25	63.30	3.30
JUL	1.11	29.20	429.50	44.70	39.00	5.70	3.80	0.25	3.20	95.50	4.80
AUG	0.53	29.70	581.30	77.00	64.00	13.00	2.00	0.67	5.60	50.70	7.00
SEP	1.76	26.40	444.10	72.40	58.70	13.70	3.10	1.80	2.70	101.40	2.90
OCT	1.05	26.50	450.70	93.20	76.00	17.20	2.00	0.40	2.50	92.30	3.70
NOV	0.85	32.00	921.00	48.30	44.50	3.80	1.00	0.25	1.80	52.70	8.00
DEC	0.57	31.00	649.00	57.50	48.00	9.50	16.50	1.50	2.00	41.50	6.00
JAN	1.05	29.00	378.00	33.50	25.00	8.50	0.0	0.0	3.00	95.50	5.00
FEB	0.69	30.30	167.00	17.00	15.00	2.00	0.0	0.0	6.70	41.30	6.30
MAR	1.93	26.70	643.00	58.20	45.40	12.80	3.10	1.30	1.60	41.70	4.90
APR	0.54	33.60	640.70	61.70	50.40	11.30	33.00	11.70	5.30	67.30	5.70
MAY	1.46	30.00	473.40	56.80	41.90	14.90	7.00	2.63	2.50	29.13	5.60
JUN	0.43	33.50	777.50	44.00	39.50	4.50	0.0	0.0	4.00	115.50	9.50

ATTACK AIRCRAFT REGRESSION ANALYSIS DATA BASE FOR FISCAL YEARS JULY 1972-JUNE 1974

TABLE A1

MONTH	RATE	AGE	TTIME	TOT90	DAY90	NITE90	CLDAY	CLNITE	ACTOUR	ACHRS	DNA
JUL	no major accidents this month.										
AUG	2.94	30.10	533.60	59.80	55.60	4.25	2.00	0.0	4.30	144.00	5.10
SEP	1.20	25.60	452.30	82.70	75.30	7.33	0.0	0.0	3.33	126.70	1.70
OCT	0.81	32.00	1577.00	64.00	58.50	5.50	0.0	0.0	2.50	92.00	8.00
NOV	1.97	27.20	338.40	50.40	45.60	4.80	3.25	0.0	4.00	222.00	2.20
DEC	0.88	27.50	564.00	75.50	48.50	27.00	2.00	1.00	7.00	17.00	3.50
JAN	0.46	26.00	328.00	53.00	46.00	7.00	0.0	0.0	4.00	22.00	2.00
FEB	1.10	25.70	265.60	59.00	51.00	8.00	1.33	0.0	1.33	70.70	7.50
MAR	0.67	28.00	590.00	30.00	28.50	1.50	0.0	0.0	5.50	44.50	9.50
APR	1.87	30.50	378.60	62.80	49.80	13.00	0.33	0.0	3.50	148.00	7.20
MAY	1.43	29.70	829.50	114.50	102.70	11.75	8.00	0.0	3.25	186.80	5.30
JUN	no major accidents this month.										
JUL	2.22	28.80	330.20	46.10	43.10	3.00	0.0	0.0	4.20	136.20	4.70
AUG	1.66	26.40	614.40	70.80	63.00	7.80	3.00	0.40	4.20	79.60	3.50
SEP	1.16	28.30	595.30	80.30	64.30	13.00	5.33	2.00	2.33	118.00	6.50
OCT	1.15	26.30	349.00	80.00	79.00	1.00	0.0	0.0	2.00	65.00	3.50
NOV	3.02	27.20	620.00	47.80	40.00	7.86	2.33	1.00	2.14	151.60	4.70
DEC	0.50	28.00	177.00	17.00	17.00	0.0	0.0	0.0	5.00	102.00	5.00
JAN	0.47	27.00	891.00	99.00	96.00	3.00	0.0	0.0	1.00	181.00	6.00
FEB	1.61	29.30	721.00	70.80	65.30	5.50	0.0	0.0	4.80	83.00	4.50
MAR	2.00	28.80	589.80	41.00	28.30	12.67	3.33	0.33	2.67	57.60	3.80
APR	0.70	32.00	633.50	90.00	85.00	5.00	0.0	0.0	6.50	86.00	8.50
MAY	1.37	26.50	638.00	67.30	58.30	9.00	0.0	0.0	2.50	57.80	3.80
JUN	1.16	27.30	903.70	88.70	78.00	10.70	1.67	0.0	1.30	49.00	4.00
JUL	0.40	26.00	415.00	65.00	64.00	1.00	0.0	0.0	1.00	74.00	2.00
AUG	no major accidents this month.										
SEP	1.54	27.00	613.70	78.00	71.30	6.75	1.50	0.0	2.75	89.30	5.00
OCT	1.46	27.00	420.20	110.20	93.80	16.50	0.0	0.0	2.25	35.30	4.00
NOV	data point deleted due to incomplete information										
DEC	no major accidents this month.										
JAN	1.18	29.00	295.50	22.50	16.50	6.00	0.0	0.0	4.50	105.50	7.00
FEB	1.54	30.30	167.00	17.00	15.00	2.00	0.0	0.0	6.67	41.30	6.30
MAR	1.61	25.20	301.50	63.50	54.50	9.00	0.0	0.0	2.67	33.30	6.00
APR	1.15	33.60	640.70	61.70	50.40	11.30	33.00	11.70	5.30	67.30	5.70
MAY	0.78	29.00	436.00	33.00	30.00	3.00	0.0	0.0	4.00	5.00	6.00
JUN	0.43	40.00	500.00	34.00	48.00	6.00	0.0	0.0	7.00	175.00	15.00

A-4 AIRCRAFT REGRESSION ANALYSIS DATA BASE FOR FISCAL YEARS JULY 1972-JUNE 1974

TABLE A2

MONTH	RATE	AGE	TTIME	TOT90	DAY90	NITE90	CLDAY	CLNITE	ACTOUR	ACHRS	DNA
JUL	1.32	33.00	100.00	87.00	57.00	30.00	12.00	8.00	2.00	20.00	9.00
AUG	1.13	28.00	429.00	100.00	86.00	14.00	16.00	5.00	3.00	58.00	3.00
SEP	no major accidents this month.										
OCT	3.92	29.00	407.00	68.30	57.00	11.30	11.30	3.60	2.00	57.00	3.70
NOV	1.22	38.00	268.00	50.00	44.00	6.00	0.0	0.0	1.00	56.00	15.00
DEC	no major accidents this month.										
JAN	1.25	29.00	864.00	103.00	67.00	36.00	5.00	4.00	2.00	25.00	12.00
FEB	no major accidents this month.										
MAR	no major accidents this month.										
APR	2.77	25.00	250.70	78.30	59.30	19.00	12.60	5.00	2.00	81.00	2.00
MAY	1.63	24.50	108.00	69.50	62.50	7.00	3.50	0.50	3.00	65.00	2.00
JUN	0.89	37.00	1308.00	115.00	97.00	18.00	36.00	8.00	5.00	25.00	12.00
JUL	3.16	28.60	427.00	82.00	71.00	11.00	15.50	4.50	3.60	109.00	7.00
AUG	1.92	26.5C	410.00	55.00	46.50	8.50	0.0	0.0	4.50	67.00	2.50
SEP	no major accidents this month.										
OCT	1.77	27.00	693.00	113.00	78.00	35.00	14.00	8.50	3.00	204.50	2.00
NOV	1.80	34.00	323.00	81.50	59.00	22.50	5.50	3.50	2.50	153.50	9.00
DEC	2.31	25.00	412.00	113.50	87.00	26.00	0.0	0.0	2.00	88.00	2.00
JAN	no major accidents this month.										
FEB	no major accidents this month.										
MAR	1.12	34.00	907.00	33.00	26.00	7.00	0.0	0.0	3.00	93.00	11.00
APR	no major accidents this month.										
MAY	3.03	26.60	343.60	68.00	42.70	25.30	11.30	5.00	2.30	59.00	2.70
JUN	no major accidents this month.										
JUL	1.30	35.00	676.00	50.00	48.00	2.00	23.00	2.00	4.00	46.00	10.00
AUG	no major accidents this month.										
SEP	1.42	27.0C	93.00	59.00	40.00	19.00	0.0	0.0	2.00	176.00	1.00
OCT	no major accidents this month.										
NOV	2.83	33.50	1144.00	40.50	36.00	4.50	0.0	0.0	2.50	7.00	10.00
DEC	no major accidents this month.										
JAN	no major accidents this month.										
FEB	no major accidents this month.										
MAR	1.12	26.00	283.00	50.00	36.00	14.00	0.0	0.0	2.00	19.00	2.00
APR	no major accidents this month.										
MAY	1.10	27.00	266.00	59.00	28.00	31.00	2.00	0.0	3.00	16.00	3.00
JUN	no major accidents this month.										

A-6 AIRCRAFT REGRESSION ANALYSIS DATA BASE FOR FISCAL YEARS JULY 1972-JUNE1974

TABLE A3

MONTH	RATE	AGE	TTIME	TOT90	DAY90	NITE90	CLDAY	CLNITE	ACTOUR	ACHRS	DNA
JUL	0.60	25.00	244.00	87.00	67.00	20.00	21.00	6.00	1.00	190.00	1.00
AUG	0.58	26.00	189.00	62.00	52.00	10.00	7.00	2.00	1.00	126.00	1.00
SEP	2.51	29.60	714.20	77.20	66.40	10.80	2.60	0.80	2.00	91.00	5.60
OCT	2.35	30.50	452.80	67.50	53.00	14.50	7.75	1.75	1.25	139.70	5.70
NOV	2.13	29.30	239.70	64.00	48.00	16.00	3.50	0.50	1.00	79.00	5.00
DEC	2.09	27.70	319.70	81.00	66.70	14.30	0.0	0.0	1.00	126.70	3.70
JAN	3.00	28.20	310.20	72.00	57.60	14.40	10.60	2.20	1.20	128.80	4.40
FEB	2.77	25.00	268.30	69.30	48.80	20.50	12.80	2.30	1.80	107.50	2.70
MAR	3.61	29.20	457.30	56.00	40.80	15.20	8.20	2.80	1.30	139.80	5.00
APR	1.11	28.00	330.00	59.50	48.00	11.50	0.0	0.0	1.50	107.00	5.00
MAY	1.29	31.70	471.00	68.00	55.00	13.00	10.00	3.00	1.30	98.00	9.10
JUN	2.83	27.70	383.20	67.00	51.30	15.70	8.70	2.70	1.80	229.40	3.20
JUL	1.96	26.30	424.50	100.30	79.30	21.00	7.30	3.80	1.80	127.20	2.70
AUG	0.45	26.00	680.00	190.00	138.00	52.00	10.00	12.00	3.00	227.00	3.00
SEP	1.38	27.00	604.70	113.70	93.70	20.00	24.30	8.70	2.00	189.00	4.00
OCT	0.49	32.00	76.00	30.00	29.00	1.00	0.0	0.0	3.00	130.00	8.00
NOV	2.03	31.30	692.30	88.50	65.00	23.50	10.30	4.00	1.30	99.00	5.30
DEC	no major accidents this month.										
JAN	1.75	35.00	618.80	87.80	67.30	20.50	10.00	1.50	2.30	255.50	10.70
FEB	1.17	32.50	451.50	18.50	18.00	0.50	0.0	0.0	1.50	134.50	8.50
MAR	no major accidents this month.										
APR	1.79	29.00	764.00	72.70	53.40	19.30	2.70	0.70	2.70	118.30	4.30
MAY	2.12	33.50	658.80	66.30	47.30	19.00	6.80	4.00	1.50	91.30	8.50
JUN	0.63	24.00	35.00	35.00	30.00	5.00	0.0	0.0	1.00	106.00	1.00
JUL	0.62	25.00	76.00	70.00	54.00	16.00	0.0	0.0	1.00	47.00	3.00
AUG	1.19	28.50	412.50	70.00	61.00	9.00	0.0	0.0	2.50	111.00	4.50
SEP	1.35	26.00	271.00	73.50	50.00	23.50	7.50	3.50	1.50	102.50	2.00
OCT	1.22	25.50	511.50	59.00	40.50	18.50	5.00	1.00	3.00	206.50	3.00
NOV	0.73	30.00	388.60	51.00	46.00	5.00	4.00	1.00	3.00	144.00	7.00
DEC	2.03	31.00	649.00	57.50	48.00	9.50	16.50	1.50	2.00	41.50	6.00
JAN	1.79	29.00	460.50	44.50	32.00	12.50	0.0	0.0	2.00	85.50	4.00
FEB	no major accidents this month.										
MAR	2.01	28.00	330.70	51.00	37.30	13.70	8.70	4.00	2.00	48.70	4.70
APR	no major accidents this month.										
MAY	2.98	31.00	529.80	65.80	49.40	16.40	10.80	3.00	1.80	41.40	6.00

A-7 AIRCRAFT REGRESSION ANALYSIS DATA BASE FOR FISCAL YEARS JULY 1972-JUNE 1974

TABLE A4

MONTH	RATE	AGE	TTIME	TOT90	DAY90	NITE90	CLDAY	CLNITE	ACTOUR	ACHRS	DNA
JUL	0.36	26.00	131.00	48.00	34.00	14.00	5.00	2.00	2.00	188.00	3.00
AUG	1.38	26.00	488.30	77.00	63.00	14.00	10.25	4.00	4.00	83.50	2.50
SEP	1.07	27.30	382.30	46.30	41.80	4.67	0.0	0.0	5.00	75.00	3.30
OCT	1.52	29.00	522.80	34.00	31.50	2.50	0.0	0.0	6.33	89.67	7.30
NOV	0.72	29.50	285.50	84.50	68.00	16.50	17.00	6.00	2.00	149.50	4.00
DEC	1.60	26.30	367.30	64.00	54.80	9.25	8.75	2.50	3.67	21.00	2.80
JAN	2.36	26.30	192.00	39.50	34.50	5.00	6.60	0.20	2.80	82.80	3.20
FEB	1.14	30.00	1209.30	70.30	61.30	9.00	9.67	1.33	4.00	96.67	6.70
MAR	1.68	31.20	336.60	47.60	39.20	8.40	4.00	1.80	4.50	105.40	7.80
APR	3.73	29.10	614.50	78.90	65.40	13.55	3.18	1.27	3.18	91.00	4.90
MAY	1.35	27.00	214.50	61.50	47.80	13.75	10.50	0.75	2.25	64.25	3.50
JUN	1.68	28.50	837.80	87.30	71.60	15.75	5.67	1.00	2.75	197.67	4.70
JUL	4.15	27.50	538.70	81.70	68.30	13.40	1.44	0.22	4.22	140.56	3.10
AUG	4.01	27.40	373.90	72.70	63.50	9.22	5.33	1.00	4.56	120.11	3.50
SEP	2.00	26.00	426.80	70.20	65.00	5.20	9.00	1.00	3.80	80.80	4.20
OCT	0.83	27.00	337.00	33.00	21.00	12.00	6.00	2.00	3.00	37.50	1.50
NOV	1.69	29.00	448.80	88.50	70.50	18.00	10.50	4.00	2.50	229.25	6.00
DEC	4.11	28.10	484.90	61.50	49.40	12.13	10.71	1.00	3.63	75.25	3.50
JAN	2.16	25.60	347.00	68.60	57.60	11.00	4.80	1.00	3.00	164.40	2.20
FEB	1.04	26.50	86.50	37.00	30.50	6.50	0.0	0.0	2.00	21.50	1.50
MAR	2.04	26.30	175.00	71.80	65.60	6.25	0.50	0.0	3.25	33.00	2.30
APR	3.22	29.40	529.70	50.70	41.70	9.00	2.50	0.67	4.57	34.00	5.30
MAY	3.13	29.30	674.90	53.10	46.50	6.57	3.67	1.33	4.86	47.29	5.70
JUN	1.50	29.70	784.70	68.30	58.00	10.33	12.00	2.33	3.00	53.00	6.70
JUL	3.91	29.30	723.60	69.10	65.00	4.10	2.00	0.86	4.86	85.86	6.90
AUG	3.49	29.10	783.30	53.00	45.30	7.71	1.80	0.17	4.00	43.00	5.60
SEP	2.81	29.60	1307.40	51.20	42.80	8.40	7.40	3.00	3.40	49.60	6.00
OCT	5.78	27.60	410.90	47.10	34.90	12.20	4.78	1.90	5.13	57.33	3.90
NOV	3.84	28.00	567.80	68.70	61.10	7.60	0.67	0.0	3.67	32.17	4.20
DEC	0.80	28.00	182.00	91.00	62.00	29.00	16.00	3.00	3.00	25.00	1.00
JAN	2.19	32.00	916.30	45.60	39.70	6.00	8.67	0.0	2.67	29.67	9.30
FEB	0.66	35.00	705.00	39.00	34.00	5.00	0.0	0.0	1.00	21.00	12.00
MAR	0.59	26.00	101.00	51.00	40.00	11.00	0.0	0.0	4.00	11.00	1.00
APR	0.54	32.00	287.00	37.00	29.00	8.00	6.00	1.00	5.00	32.00	9.00
MAY	0.58	29.00	1286.00	75.00	36.00	39.00	0.0	0.0	2.00	14.00	6.00
JUN	2.00	30.00	421.70	23.00	21.00	2.00	0.0	0.0	4.30	32.50	18.30

FIGHTER AIRCRAFT REGRESSION ANALYSIS DATA BASE FOR FISCAL YEARS JULY 1972-JUNE 1974

TABLE A5

MONTH	RATE	AGE	TTIME	TOT90	DAY90	NITE90	CLDAY	CLNITE	ACTOUR	ACHRS	DNA
JUL	1.36	26.00	131.00	48.00	34.00	14.00	5.00	2.00	2.00	188.00	3.00
AUG	1.82	25.70	425.00	75.70	60.40	15.30	10.00	4.00	4.00	49.30	2.30
SEP	1.24	26.50	519.00	51.50	46.50	5.00	0.0	0.0	2.00	48.00	3.00
OCT	1.38	27.50	835.50	21.00	19.00	2.00	0.0	0.0	5.00	108.00	4.00
NOV	1.25	29.50	285.50	84.50	68.00	16.50	17.00	6.00	2.00	149.50	4.00
DEC	1.25	25.50	199.50	66.00	56.00	10.00	14.00	6.00	2.00	19.00	1.50
JAN	1.80	25.60	185.70	45.70	37.30	8.30	7.00	0.50	2.67	68.30	3.00
FEB	0.64	29.00	1157.00	74.00	70.00	4.00	0.0	0.0	3.00	165.00	5.00
MAR	2.13	29.50	221.30	53.30	43.30	10.00	5.00	2.25	3.30	117.00	6.00
APR	3.34	30.80	627.70	67.70	55.50	12.20	36.70	1.00	2.50	104.20	5.20
MAY	1.53	28.00	239.00	63.00	48.70	14.30	14.00	1.00	2.00	79.00	4.30
JUN	2.33	32.00	837.80	87.30	71.50	15.75	5.67	1.00	2.75	197.67	4.70
JUL	4.53	28.30	653.00	77.40	65.40	12.00	2.17	0.33	3.00	173.50	4.00
AUG	2.91	28.60	434.40	61.80	54.80	7.00	4.25	1.25	3.00	160.70	3.80
SEP	1.22	24.00	136.50	36.00	23.00	13.00	1.00	2.50	4.00	87.00	1.50
OCT	1.17	27.00	337.00	33.00	21.00	12.00	6.00	2.00	3.00	37.50	3.00
NOV	1.74	30.70	465.30	90.00	68.00	22.00	12.00	5.00	2.00	223.00	6.30
DEC	3.53	27.50	542.60	65.40	46.60	18.80	5.00	1.75	3.40	49.40	3.20
JAN	2.96	25.60	347.00	68.60	57.60	11.10	4.80	1.00	3.00	164.40	2.20
FEB	1.47	26.50	86.50	37.00	30.50	6.50	0.0	0.0	2.00	21.00	1.50
MAR	2.06	26.60	224.70	87.00	79.00	8.00	0.67	0.0	3.30	96.60	2.70
APR	3.08	30.20	685.20	56.00	48.00	12.00	2.75	1.53	3.60	31.80	6.00
MAY	2.42	29.50	701.50	61.80	52.50	9.25	66.70	2.67	3.80	47.80	5.70
JUN	0.76	29.00	918.00	97.00	86.00	13.00	8.00	4.00	3.00	38.00	6.00
JUL	2.21	28.30	1107.00	130.50	123.50	7.00	0.0	0.0	3.00	153.50	4.30
AUG	2.20	26.30	263.70	64.30	59.00	5.30	1.33	0.0	3.70	34.00	2.30
SEP	1.60	25.00	300.00	57.50	49.00	8.50	2.25	0.50	2.50	32.50	1.50
OCT	3.54	26.60	187.00	46.00	33.30	12.80	5.60	2.40	4.30	27.00	2.80
NOV	4.37	28.60	556.40	71.20	65.70	5.50	0.0	0.0	4.40	36.30	4.40
DEC	1.01	28.00	182.00	91.00	62.00	29.00	16.00	3.00	3.00	25.00	1.00
JAN	0.90	29.00	504.00	36.00	20.00	16.00	3.00	0.0	5.00	38.00	5.00
FEB	0.87	35.00	705.00	39.00	34.00	5.00	0.0	0.0	1.00	21.00	10.00
MAR	0.77	26.00	101.00	51.00	40.00	11.00	0.0	0.0	4.00	11.00	1.00
APR	0.69	32.00	287.00	37.00	29.00	8.00	6.00	1.00	5.00	32.00	9.00
MAY	0.73	29.00	1286.00	75.00	36.00	39.00	0.0	0.0	2.00	11.00	6.00
JUN	2.47	30.00	421.70	23.00	17.00	6.00	0.0	0.0	4.30	32.50	6.70

F-4 AIRCRAFT REGRESSION ANALYSIS DATA BASE FOR FISCAL YEARS JULY 1972-JUNE 1974

TABLE A6

MONTH	RATE	AGE	TTIME	TOT90	DAY90	NITE90	CLDAY	CLNITE	ACTOUR	ACHRS	DNA
JUL	0.36	32.50	371.50	69.00	43.00	26.00	3.50	2.50	6.00	65.00	8.50
AUG	0.17	36.00	19.00	19.00	19.00	0.0	0.0	0.0	3.00	257.00	14.00
SEP	0.17	26.00	342.00	143.00	124.00	19.00	11.00	6.00	5.00	14.00	2.00
OCT	no major accidents this month.										
NOV	0.35	43.50	1506.00	58.00	47.00	11.00	1.00	0.0	4.50	78.50	17.00
DEC	0.99	30.80	1552.40	162.40	134.80	27.60	5.00	0.0	3.50	156.80	7.20
JAN	0.58	28.00	999.70	123.00	84.70	38.33	0.50	0.0	5.67	353.00	4.30
FEB	0.26	34.00	34.00	19.00	10.00	9.00	0.0	0.0	8.00	75.00	14.00
MAR	0.33	36.50	82.00	37.50	33.00	4.50	0.0	0.0	6.00	169.50	13.50
APR	no major accidents this month.										
MAY	0.17	29.00	1566.00	135.00	132.00	3.00	0.0	0.0	2.00	42.00	4.00
JUN	0.17	34.00	240.00	97.00	81.00	16.00	0.0	0.0	3.00	85.00	11.00
JUL	0.38	28.50	640.00	58.00	40.50	17.50	2.00	1.50	7.00	103.00	4.00
AUG	0.16	34.00	195.00	162.00	119.00	43.00	1.00	2.00	4.00	6.00	11.00
SEP	no major accidents this month.										
OCT	no major accidents this month.										
NOV	0.18	28.00	1139.00	120.00	120.00	0.0	0.0	0.0	5.00	49.00	3.00
DEC	0.63	30.00	642.00	97.30	80.60	16.67	8.33	1.00	5.50	113.67	7.00
JAN	0.39	30.50	1852.50	173.50	165.50	8.00	3.00	0.0	4.00	536.00	9.00
FEB	0.19	39.00	900.00	45.00	36.00	9.00	0.0	0.0	9.00	5.00	16.00
MAR	0.35	40.00	748.00	79.00	62.00	17.00	0.0	0.0	4.00	208.50	16.50
APR	0.36	34.50	648.50	92.00	76.50	15.50	0.0	0.0	5.00	118.50	10.50
MAY	0.34	47.00	181.00	81.00	73.00	8.00	7.00	0.0	4.00	54.00	24.00
JUN	0.39	29.00	646.50	63.50	53.00	10.50	4.50	2.00	6.00	25.50	4.50
JUL	0.38	29.50	973.00	67.00	55.00	12.00	5.50	0.0	3.50	57.50	5.50
AUG	no major accidents this month.										
SEP	no major accidents this month.										
OCT	no major accidents this month.										
NOV	0.64	38.30	564.00	69.30	59.30	10.00	8.00	0.0	6.00	38.00	16.30
DEC	0.83	33.60	88.00	56.00	32.00	1.00	0.0	0.0	5.00	67.00	10.30
JAN	0.79	35.70	916.30	61.30	47.30	14.00	0.0	0.0	8.00	93.00	12.00
FEB	0.24	41.00	421.00	47.00	38.00	9.00	0.0	0.0	5.00	196.00	18.00
MAR	no major accidents this month.										
APR	0.41	37.00	477.00	76.00	52.50	23.50	0.0	0.0	3.50	17.50	14.50
MAY	no major accidents this month.										
JUN	no major accidents this month.										

PROPELLER AIRCRAFT REGRESSION ANALYSIS DATA BASE FOR FISCAL YEARS JULY 1972-JUNE 1974

TABLE A7

MONTH	RATE	AGE	TTIME	TOT90	DAY90	NITE90	CLDAY	CLNITE	ACTOUR	ACHRS	DNA
JUL	1.61	26.80	591.80	50.80	43.80	7.00	0.0	0.0	2.50	52.67	2.60
AUG	0.94	30.00	343.70	142.00	113.00	29.00	0.0	0.0	2.67	77.00	7.00
SEP	1.95	26.00	695.20	93.30	80.80	12.50	0.0	0.0	2.33	55.00	2.80
OCT	1.00	28.70	453.00	116.30	110.30	6.00	0.0	0.0	2.67	350.33	4.70
NOV	0.61	28.50	790.00	95.00	80.00	15.00	0.0	0.0	1.00	56.00	4.50
DEC	2.04	28.00	676.80	78.50	72.80	5.67	0.0	0.0	3.33	98.67	3.80
JAN	0.71	30.00	645.50	60.50	55.00	5.50	0.0	0.0	2.50	57.00	6.00
FEB	0.66	32.50	397.00	51.50	39.00	12.50	0.0	0.0	3.00	59.00	8.50
MAR	0.29	24.00	396.00	146.00	117.00	29.00	0.0	0.0	1.00	2.00	1.00
APR	0.88	27.30	461.70	51.30	43.30	8.00	0.0	0.0	3.50	74.50	3.30
MAY	0.86	27.70	472.70	97.00	81.30	15.67	0.0	0.0	4.30	82.70	3.00
JUN	1.73	25.50	457.80	90.10	79.10	11.00	0.0	0.0	2.83	89.17	2.80
JUL	0.57	30.00	949.00	74.00	60.00	7.00	0.0	0.0	3.50	60.00	5.00
AUG	0.62	25.50	332.00	71.00	67.00	4.00	0.0	0.0	4.00	39.00	2.50
SEP	0.91	33.00	477.50	75.00	70.50	4.50	0.0	0.0	2.33	39.00	2.00
OCT	0.98	30.30	998.70	69.00	65.70	3.30	0.0	0.0	2.67	216.00	8.30
NOV	0.63	25.50	824.50	90.00	83.50	6.50	0.0	0.0	1.00	115.00	3.50
DEC	1.43	26.00	186.00	59.80	52.30	7.50	0.0	0.0	3.75	27.00	2.50
JAN	1.64	30.20	443.60	51.60	45.00	6.60	0.0	0.0	3.20	72.80	5.40
FEB	0.65	27.50	307.00	38.00	33.50	4.50	0.0	0.0	3.00	90.50	5.50
MAR	1.65	29.80	687.20	49.40	41.80	7.60	0.0	0.0	2.80	100.80	7.60
APR	0.62	25.00	444.00	61.50	58.00	3.50	0.0	0.0	3.50	108.00	2.00
MAY	no major accidents this month.										
JUN	0.70	31.00	885.50	73.50	65.00	8.50	0.0	0.0	5.00	116.00	9.00
JUL	1.04	27.30	414.00	45.00	44.00	1.00	0.0	0.0	3.00	56.30	4.30
AUG	1.41	32.00	535.50	67.80	63.50	4.25	0.0	0.0	4.67	91.30	8.30
SEP	no major accidents this month.										
OCT	0.74	26.50	509.50	45.00	36.50	8.50	0.0	0.0	8.00	45.00	2.00
NOV	1.19	30.00	758.70	44.00	38.70	5.33	0.0	0.0	2.67	33.67	6.70
DEC	2.15	32.00	1448.00	110.00	93.80	16.25	0.0	0.0	2.50	46.50	7.30
JAN	no major accidents this month.										
FEB	0.82	30.50	592.50	41.50	37.00	4.50	0.0	0.0	4.00	110.50	6.50
MAR	0.35	33.00	484.00	31.00	23.00	8.00	0.0	0.0	4.00	27.00	10.00
APR	0.93	28.30	633.70	46.30	40.30	6.00	0.0	0.0	4.50	78.00	3.70
MAY	0.85	28.00	510.50	57.50	54.00	3.50	0.0	0.0	2.00	29.50	3.00
JUN	0.36	25.00	368.00	43.00	42.00	1.00	0.0	0.0	4.00	13.00	2.00

HELICOPTER REGRESSION ANALYSIS DATA BASE FOR FISCAL YEARS JULY 1972–JUNE 1974

TABLE A8

LIST OF REFERENCES

1. Brictson, C.A.; Pitrella, F.B.; and Wulfeck, JW, Analysis of Aircraft Carrier Landing Accidents (1965 to 1969), Dunlap and Associates, ONR, Washington, D.C., November 1969

2. Butterworth, R.W.; and Marshall, K.T., A Survey of Renewal Theory with Emphasis on Approximations, Bounds, and Applications, Office of Naval Research, Arlington, Virginia, May 1974.

3. Collicott, C.R.; Muir, D.E.; and Dell, A.H., U.S. Naval Aviation Safety, OEG Study 766, October 1972.

4. Draper, N.R.; and Smith, H., Applied Regression Analysis, John Wiley & Sons, Inc., New York, 1966.

5. Goorney, A.B. The Human Factor in Aircraft Accidents - Investigation of Background Factors of Pilot Error Accidents, Flying Personnel Research Committee, Ministry of Defense, Great Britain, July 1965.

6. Kowalsky, N.B.; Masters, R.L.; Stone, R.B.; Bubcock, G.L.; and Rypka, E.W., An Analysis of Pilot Error-Related Aircraft Accidents NASA Contractor Report 2444, June 1974.

7. Manual of Code Classification for Navy Aircraft Accident, Incident, and Ground Accident Reporting, Records Division, Records and Data Processing Department, Naval Safety Center, 1 July 1972.

8. Meyers, H.B., Jr., Pilot Accident Potential as Related to Total Flight Experience and Recency and Frequency of

Flying, Unpublished Master's Thesis, Naval Postgraduate School, Monterey, Ca., September 1974.

9. Navy Aircraft Accident, Incident, and Ground Accident Reporting Procedures, OPNAVINST 3750.6J of 13 December 1973.

10. Nie, N.H.; Hull, C.H.; Jenkins, J.G.; Steinbrenner, K.; and Bent, D. H.;, Statistical Package for the Social Sciences, Second Edition, McGraw-Hill, New York, 1975.

11. Poock, G.K., Trends in Major Aircraft Accident Rates, Man-Machine Systems Design Laboratory, Naval Postgraduate School, Monterey, Ca, June 1976.

12. Robino, A.P., LCDR, USN, AIRLANT March Phenomena Study, Naval Safety Center, Norfolk, Virginia, November 1972.

13. Stucki, L.V. and Maxwell, J.S., Analysis of the Variable Behavior Manifested in all Navy/Marine Major Aircraft Accident Rates, Unpublished Master's Thesis, Naval Postgraduate School, Monterey, Ca., September 1975.

14. Zeller, A. P., Current Flying and Accident Potential, Defense Documentation Agency Report Number 060728, Defense Documentation Agency, Washington, D.C., April 1961.

INITIAL DISTRIBUTION LIST

		Copies
1.	Defense Documentation Center Cameron Station Alexandria, Va. 22314	2
2.	Chief of Naval Personnel Pers 11b Department of the Navy Washington, D. C. 20370	1
3.	Library, Code 0212 Naval Postgraduate School Monterey, California 93940	2
4.	Department Chairman, Code 55 Department of Operations Research Naval Postgraduate School Monterey, California 93940	2
5.	Assoc. Professor G. K. Poock, Code 55Pk Department of operations Research Naval Postgraduate School Monterey, California- 93940	3
6.	Assist. Professor D. E. Neil, Code 55Ni Department of Operations Research Naval Postgraduate School Monterey, California 93940	1
7.	Director, Aviation Safety Programs Naval Postgraduate School Monterey, California 93940	1

8. Naval Safety Center 1
Naval Air Station
Norfolk, Virginia 23511

9. LCDR R. W. Mister, Code 1155 1
Naval Safety Center
Naval Air Station
Norfolk, Virginia 23511

10. Lt. G. F. Johnson 1
5932 Blacksmith Rd.
Bonita, California 92002